but not after propranolol ($p = 0.715$, $R^2 = 10\%$, adjusted $R^2 = 0\%$). The primary peak incidence of the maximal amount of SI occurred between 8 a.m. and 9 a.m. before no AA drug, between 8 a.m. and 10 a.m. after no AA drug, and between 8 a.m. and 11 a.m. before propranolol. There was no secondary peak. These data show that there is a circadian variation of the maximal amount of SI in elderly pts with heart disease which is abolished by propranolol.

1015-75 Detection of Aortic Plaques is not Predictive of Coronary Artery Disease in the Elderly: A Biplane Transesophageal Echocardiographic Study

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Atherosclerotic aortic plaques detected by transesophageal echocardiography (TEE) have been reported to be a marker for coronary artery disease (CAD). Its significance may particularly be important in elderly population, though there are no data yet available. To elucidate the significance of aortic plaques in the elderly, we performed TEE on 84 patients (pts) (44 men, 40 women, age 61 ± 11 years) who had previously undergone coronary arteriography.

Results: (1) Significant CAD (≥75% stenosis) was detected in at least one major coronary artery in 26 of the 84 pts. Aortic plaques were detected by TEE in 24 of the 26 pts with CAD (92%) and in 32 of 58 pts without CAD (55%) ($p < 0.01$). (2) In pts aged ≥70 years ($n = 25$), aortic plaques were present in 13 of 14 pts with CAD (93%) and 10 of 11 pts without CAD (91%) (p = ns). In pts aged <70 years ($n = 59$), aortic plaques were present in 10 of 12 pts with CAD (83%) and 22 of 47 pts without CAD (47%) ($p = 0.02$). (3) The independent association between CAD and age, the presence of aortic plaques on TEE and other coronary risk factors was examined by multiple regression analysis. In pts aged ≥70 years, the presence of aortic plaques on TEE failed to be a predictor of significant CAD, although it was indeed a strong predictor of CAD in pts aged <70 years ($p < 0.01$).

Conclusion: In elderly pts, atherosclerotic aortic plaque detected by transesophageal echocardiography is not useful in predicting significant coronary artery disease. It is useful only in a relatively younger population.

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Wednesday, March 22, 1995, Noon–2:00 p.m.
Ernest N. Morial Convention Center, Hall E
Presentation Hour: Noon–1:00 p.m.

1016-51 From Myocardial O_2 Consumption to Mean Arterial Power — Analysis of Optimal Cardiovascular Performance

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Mathematical model and numerical simulation are used to analyze optimal conditions of cardiovascular performance, with an emphasis on the effect of ventricular-arterial (VA) coupling. The following research questions were posed: Does the VA-coupling affect the cardiovascular system (CVS) performance in addition to the direct effects of the left ventricle and of the vascular load? Is there an optimal coupling state? Does the CVS in human subjects, either healthy or diseased, operate with optimal VA-coupling? and finally, is it possible to improve the CVS performance by controlling the VA-coupling? To answer these questions, a clinically oriented integral model of the CVS is introduced, based on the ventricular and arterial elastances. The main advantages of the model are its simplicity and the fact that all its variables can be measured non-invasively in the clinical practice. Traditionally, the optimal state of CVS operation was evaluated by two criteria — the energetic efficiency of the left ventricle and the efficiency of energy transfer through the vascular system. In the present study a combined criterion of the total energetic efficiency is utilized — from the input metabolic energy consumed by the ventricle to the net energy available to the peripheral tissues. It is found that optimal coupling for maximal global efficiency depends in a complex, non-linear way on all the classical determinants of CVS performance — the preload, the myocardial contractility, the afterload and the heart rate. Response surfaces of the analyzed variables as function of two independent variables were generated by numerical simulation. Based on the analysis of the global efficiency as the optimization criterion, answers to the research questions were found: The VA-coupling affects the CVS performance in addition to the direct effects of its determinants; there is an optimal state of coupling which results in maximal efficiency; the CVS in healthy subject operates in the region of optimal coupling; during stress, changes in the state of coupling result in additional contribution to CVS performance; in patients with left ventricular dysfunction the efficiency is reduced and it further decreases during exercise. The model shows that there is, however, an optimal coupling which improves performance even in cases of severe heart failure. This optimal state can theoretically be approached by titrating the vascular resistance and the end-diastolic volume (the preload) to optimal levels. These results suggest, and lay the theoretical foundation for the notion, that vasodilator drugs can be used to optimize VA-coupling and CVS performance in heart failure patients.

1016-52 Real-Time Acoustic Assessment of Mechanical Heart Valves

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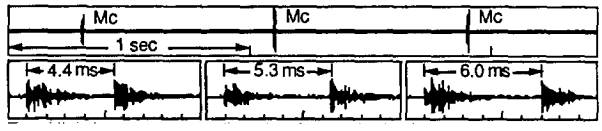
Reliable assessment of mechanical heart valve function remains a difficult clinical problem. We have shown that 1) leaflets of bileaflet mechanical valves do not close simultaneously and 2) the dominant energy contained in closing sounds created by these valves is in the ultrasonic range (>20 kHz). Taking advantage of these findings, we designed a real-time Macintosh-based system that permits a clinician to evaluate dynamic characteristics of these valves by listening to closing sounds played back at slow speeds. Valve sounds detected by a high-frequency accelerometer microphone are amplified and undergo a 12-bit analog-to-digital conversion at 140 kHz. During data acquisition closing valve sounds are digitally detected for immediate playback through an audio output. The user can select the speed and length of sound playback. While the expanded closing sounds are plotted on the screen, the audio output gives the clinician a unique appreciation of closing valve dynamics. Sound output can be through either a dedicated digital-to-analog converter or the regular Macintosh sound interface, thus allowing previously recorded data to be presented on any standard Macintosh system. A recording obtained from a patient with a bileaflet mitral valve is shown below.



Slowing playback speed reduces dominant frequencies of valve closure sounds into the audible range making it easy to recognize sounds from individual leaflet impacts as well as noises caused by leaflets scraping against valve structures. This system is directly applicable to sounds created by any type of mechanical heart valve.

Conclusions: Slow speed playback of high-frequency sounds created by closing mechanical heart valves gives important insight into valve function. This technique, readily implemented with personal computers, provides a simple and inexpensive method to screen patients with mechanical heart valves.

1016-53 An Inexpensive, Easy to Use and Highly Portable Quantitative Angiographic System

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Quantitative angiography is considered the "gold standard" for the assessment of coronary arterial dimensions. The presence in the actual systems of one or more disadvantages such as high cost, difficulty in usage and poor portability, have prevented the wide utilization of this method. To implement a similar system, the acquisition of the computer, software, digitizing board and cineprojector with CCD camera is usually required. We developed a system running on every Macintosh computer with only one special requirement, that of a commercially available slide scanner. A public domain software, NIH Image (written by Wayne Rasband) was modified and expanded to perform the following tasks: acquisition and storage of the digitized angiographic frames, automatic edge detection and measurements, and saving of the results in a text format file, readable from every database, spreadsheet or statistical package. Films (courtesy of Dr. Patrick W. Serruys, Rotterdam) of coronary phantoms with known size (0.5, 0.7, 1.0, 1.4, 1.9 mm) implanted in pigs, were used for system validation. The angiographic frames (24 x 18 mm) were digitized with a spatial resolution of 1850 pixels/inch (slide scanners with higher resolution are also available) and 256 gray levels. Using isocenter calibration, the measurements resulted in a correlation coefficient of 0.96 ($y = 0.86x + 0.12$), accuracy of −0.03 mm and precision of 0.15 mm. A correlation coefficient of 0.92 ($y = 0.67x + 0.33$), an accuracy of −0.03 mm and a precision of 0.23 mm were found using catheter calibration. With the same phantoms, the mean reproducibility was 0.08 mm for the interpolated reference diameter (RD), 0.03 mm for the minimal luminal diameter (MLD), 1.4% for the diameter stenosis (DS) and 0.6 mm for the lesion length. The